

What is claimed is:

1           1. A method of evaluating whiteness of light emitted from  
2 a light source, comprising the steps of:

3           calculating chroma  $C$ , using a method defined by the  
4 CIE 1997 Interim Color Appearance Model (Simple Version);  
5 and

6           calculating whiteness  $W$  from the chroma  $C$  using an  
7 equation (1),

$$W = aC + b \cdot \cdot \cdot (1)$$

9           where the coefficient  $a$  is a negative real number  
10 and the coefficient  $b$  is a positive real number.

1           2. The method of Claim 1,

2           wherein the whiteness  $W$  is 100 when the chroma  $C$  is 0.

1           3. The method of Claim 2,

2           wherein the whiteness  $W$  is 50 under a standard  
3 illuminant  $A$ .

1           4. The method of Claim 1,

2           wherein the chroma  $C$  is a chroma of the light emitted  
3 from the light source, and

4           the coefficient  $a$  is -5.3 and the coefficient  $b$  is 100.

1           5. The method of Claim 1,

2 wherein the chroma  $C$  is a chroma of light obtained  
3 when the light from the light source is reflected off from  
4 a surface of an object whose Munsell value and Munsell chroma  
5 is 9.5 and 0, respectively, and  
6 the coefficient  $a$  is -4.4 and the coefficient  $b$  is 100.

1 6. The method of Claim 1,  
2 wherein the chroma is a chroma of light obtained when  
3 the light emitted from the light source is reflected off  
4 a blank surface of a newspaper, and  
5 the coefficient  $a$  is -3.3 and the coefficient  $b$  is 100.

1 7. A method of evaluating comparative whiteness  
2 of light emitted from two light sources, comprising the  
3 steps of:

4 calculating chroma  $C_1$  of light from a first  
5 light source and chroma  $C_2$  of light from a second light  
6 source using a method defined by the CIE 1997 Interim  
7 Color Appearance Model(Simple Version); and  
8 calculating comparative whiteness  $W_c$  from the chroma  $C_1$   
9 and the chroma  $C_2$ , using an equation (2),

10 
$$W_c = (C_1 - C_2) / C_1 \cdot \cdot \cdot (2).$$

1 8. A light source, being characterized by:  
2 emitting light whose whiteness is no smaller

3 than 85 and whose visual clarity index is no smaller than 110,  
4 the whiteness  $W$  being calculated using chroma  $C$  of the light  
5 and an equation (3),

$$6 \quad W = -5.3C + 100 \quad \dots (3)$$

7 wherein the chroma  $C$  is calculated using a method  
8 defined by the CIE 1997 Interim Color Appearance Model (Simple  
9 Version)

1 9. The light source of Claim 8,  
2 wherein the light source is a fluorescent lamp  
3 containing a phosphor layer, the light source emitting light  
4 whose peak emissions are in four wavelength ranges of 440nm to  
5 470nm, 505nm to 530nm, 540nm to 570nm, and 600nm to 620nm; and  
6 wherein a ratio of a radiant energy  $Q_v$  to a radiant  
7 energy  $Q_g$  satisfies an inequality (4) for a correlated color  
8 temperature  $T[K]$

$$9 \quad Q_g/Q_v \geq -0.11 \times 10^4/T + 0.30 \quad \dots (4)$$

10 wherein the radiant energy  $Q_v$  is in a wavelength of  
11 380nm to 780nm and radiant energy  $Q_g$  in a wavelength  
12 of 505nm to 530nm.

1 10. The light source of Claim 9,  
2 wherein the phosphor layer contains, as major components:  
3 a phosphor containing bivalent Europium as an

4 emission center and having a peak emission at a wavelength range  
5 of 440nm to 470nm;

6 a phosphor containing bivalent manganese as an emission  
7 center and having a peak emission at a wavelength range of 505nm  
8 to 530nm;

9 a phosphor containing trivalent terbium as an emission  
10 center and having a peak emission at a wavelength range of 540nm  
11 to 570nm; and

12 a phosphor containing trivalent europium as an emission  
13 center and having a peak emission at a wavelength range of 600nm  
14 to 620nm.

1 11. The light source of Claim 10,

2 wherein the phosphor containing the bivalent europium as  
3 an emission center and having a peak emission at a wavelength  
4 range of 440nm to 470nm is composed of at least one of:

5  $\text{BaMgAl}_{10}\text{O}_{17}:\text{Eu}^{2+}$ ;

6  $\text{BaMgAl}_{10}\text{O}_{17}:\text{Eu}^{2+}, \text{Mn}^{2+}$  ; and

7  $(\text{Ba}, \text{Ca}, \text{Sr}, \text{Mg})_{10}(\text{PO}_4)_6\text{Cl}_2:\text{Eu}^{2+}$

8 wherein compounds on the left side denote host crystals,  
9 and ions on the right side are emission centers contained in  
10 the phosphors.

1 12. The light source of Claim 10,

2 wherein the phosphor containing the bivalent manganese

3 as an emission center and having a peak emission at a wavelength  
4 range of 505nm to 530nm is composed of at least one of:

5 BaMgAl<sub>10</sub>O<sub>17</sub>:Eu<sup>2+</sup>, Mn<sup>2+</sup>;

6 CeMgAl<sub>11</sub>O<sub>19</sub>:Mn<sup>2+</sup>;

7 Ce (Mg, Zn) Al<sub>11</sub>O<sub>19</sub>:Mn<sup>2+</sup>;

8 Zn<sub>2</sub>SiO<sub>4</sub>:Mn<sup>2+</sup>; and

9 CeMgAl<sub>11</sub>O<sub>19</sub>:Tb<sup>3+</sup>, Mn<sup>2+</sup>

10 wherein compounds on the left side denote host crystals,  
11 and ions on the right side are emission centers contained in  
12 the phosphors.

1 13. The light source of Claim 10,

2 wherein the phosphor containing the trivalent terbium  
3 as an emission center and having an emission peak at a wavelength  
4 range of 540nm to 570nm is composed of at least one of:

5 LaPO<sub>4</sub>:Ce<sup>3+</sup>, Tb<sup>3+</sup>; and

6 CeMgAl<sub>11</sub>O<sub>19</sub>:Tb<sup>3+</sup>

7 wherein compounds on the left side denote host crystals,  
8 and ions on the right side are emission centers contained in  
9 the phosphors.

1 14. The light source of Claim 10,

2 wherein the phosphor containing the trivalent europium  
3 as an emission center and having an emission peak at a wavelength  
4 range of 600nm to 620nm is composed of at least one of:

5            $\text{Y}_2\text{O}_3:\text{Eu}^{3+}$ ; and

6            $\text{Gd}_2\text{O}_3:\text{Eu}^{3+}$

7           wherein compounds on the left side denote host crystals,  
8   and ions on the right side are emission centers contained in  
9   the phosphors.

1           15. The light source of Claim 9,

2           wherein the phosphor layer has, as major components:

3           a phosphor containing both bivalent europium and bivalent  
4   manganese as emission centers and having emission peaks both  
5   at a wavelength range of 440nm to 470nm and at 505nm to 530nm;

6           a phosphor containing trivalent terbium as an emission  
7   center and having an emission peak at a wavelength range of 540nm  
8   to 570nm; and

9           a phosphor containing trivalent europium as an emission  
10   center and having an emission peak at a wavelength range of 600nm  
11   to 620nm.

1           16. The light source of Claim 15,

2           wherein the phosphor containing the bivalent europium and  
3   bivalent manganese as emission centers and having emission peaks  
4   both at a wavelength range of 440nm to 470nm and at 505nm to  
5   530nm is

6            $\text{BaMgAl}_{10}\text{O}_{17}:\text{Eu}^{2+}, \text{Mn}^{2+}$

7           wherein a compound on the left side denotes a host crystal,

8 and ions on the right side are emission centers contained in  
9 the phosphor.

1 17. The light source of Claim 15,  
2 wherein the phosphor containing the trivalent terbium  
3 as an emission center and having an emission peak at a wavelength  
4 range of 540nm to 570nm is composed of at least one of:

5  $\text{LaPO}_4:\text{Ce}^{3+}, \text{Tb}^{3+}$ ; and

6  $\text{CeMgAl}_{11}\text{O}_{19}:\text{Tb}^{3+}$

7 wherein compounds on the left side denote host crystals,  
8 and ions on the right side are emission centers contained in  
9 the phosphors.

1 18. The light source of Claim 15,  
2 wherein the phosphor containing the trivalent europium  
3 as an emission center and having an emission peak at a wavelength  
4 range of 600nm to 620nm is composed of at least one of:

5  $\text{Y}_2\text{O}_3:\text{Eu}^{3+}$ ; and

6  $\text{Gd}_2\text{O}_3:\text{Eu}^{3+}$

7 wherein compounds on the left side denote host crystals,  
8 and ions on the right side are emission centers contained in  
9 the phosphors.

1 19. The light source of Claim 9,  
2 wherein the phosphor layer contains, as major

3 components:

4 a phosphor containing bivalent europium as an emission  
5 center and having an emission peak at 440nm to 470nm;

6 a phosphor containing both trivalent terbium and bivalent  
7 manganese as emission centers and having emission peaks both  
8 at a wavelength range of 505nm to 530nm and at 540nm to 570nm;  
9 and

10 a phosphor containing trivalent europium as an emission  
11 center and having an emission peak at 600nm.

1 20. The light source of Claim 19,

2 wherein the phosphor containing the bivalent europium as  
3 an emission center and having a peak emission at a wavelength  
4 range of 440nm to 470nm is composed of at least one of:

5  $\text{BaMgAl}_{10}\text{O}_{17}:\text{Eu}^{2+}$ ;

6  $\text{BaMgAl}_{10}\text{O}_{17}:\text{Eu}^{2+}, \text{Mn}^{2+}$  ; and

7  $(\text{Ba}, \text{Ca}, \text{Sr}, \text{Mg})_{10}(\text{PO}_4)_6\text{Cl}_2:\text{Eu}^{2+}$

8 wherein compounds on the left side denote host crystals,  
9 and ions on the right side are emission centers contained in  
10 the phosphors.

1 21. The light source of Claim 19,

2 wherein the phosphor containing the trivalent terbium  
3 and the bivalent manganese as emission centers and having peak  
4 emissions both at a wavelength range of 505nm to 530nm and at



5 540nm to 570nm is

6  $\text{CeMgAl}_{11}\text{O}_{19}:\text{Tb}^{3+}, \text{Mn}^{2+}$

7 wherein a compound on the left side denotes a host crystal,  
8 and ions on the right side are emission centers contained in  
9 the phosphor.

1 22. The light source of Claim 19,

2 wherein the phosphor containing the trivalent europium  
3 as an emission center and having an emission peak at a wavelength  
4 range of 600nm to 620nm is composed of at least one of:

5  $\text{Y}_2\text{O}_3:\text{Eu}^{3+}$ ; and

6  $\text{Gd}_2\text{O}_3:\text{Eu}^{3+}$

7 wherein compounds on the left side denote host crystals,  
8 and ions on the right side are emission centers contained in  
9 the phosphors.

1 23. A light source, being characterized by:

2 emitting light whose whiteness  $W$  is no smaller than 85,  
3 and whose visual clarity index is no smaller than 115, the  
4 whiteness  $W$  being calculated using chroma  $C$  of the light and  
5 an equation(5)

6 
$$W = -5.3C + 100 \cdots (5)$$

7 wherein the chroma  $C$  is calculated using a method defined  
8 by the CIE 1997 Interim Color Appearance Model (Simple Version).

1           24. The light source of Claim 23,  
2           wherein the light source is a fluorescent lamp  
3           containing a phosphor layer, the light source emitting light  
4           whose peak emissions are in four wavelength ranges of 440nm to  
5           470nm, 505nm to 530nm, 540nm to 570nm, and 600nm to 620nm; and  
6           wherein a ratio of a radiant energy  $Q_v$  to a radiant  
7           energy  $Q_g$  satisfies an inequality (6) for a correlated color  
8           temperature  $T[K]$

9                     
$$Q_g/Q_v \geq -0.11 \times 10^4 / T + 0.30 \quad \dots (6)$$

10           wherein the radiant energy  $Q_v$  is in a wavelength of  
11           380nm to 780nm and radiant energy  $Q_g$  in a wavelength  
12           of 505nm to 530nm.

1           25. The light source of Claim 24,  
2           wherein the phosphor layer contains, as major components:  
3           a phosphor containing bivalent Europium as an  
4           emission center and having a peak emission at a wavelength range  
5           of 440nm to 470nm;

6           a phosphor containing bivalent manganese as an emission  
7           center and having a peak emission at a wavelength range of 505nm  
8           to 530nm;

9           a phosphor containing trivalent terbium as an emission  
10           center and having a peak emission at a wavelength range of 540nm  
11           to 570nm; and

12           a phosphor containing trivalent europium as an emission

1 center and having a peak emission at a wavelength range of 600nm  
2 to 620nm.

1 26. The light source of Claim 25,  
2 wherein the phosphor containing the bivalent europium as  
3 an emission center and having a peak emission at a wavelength  
4 range of 440nm to 470nm is composed of at least one of:

5 BaMgAl<sub>10</sub>O<sub>17</sub>:Eu<sup>2+</sup>;  
6 BaMgAl<sub>10</sub>O<sub>17</sub>:Eu<sup>2+</sup>, Mn<sup>2+</sup> ; and  
7 (Ba, Ca, Sr, Mg)<sub>10</sub>(PO<sub>4</sub>)<sub>6</sub>Cl<sub>2</sub>:Eu<sup>2+</sup>

8 wherein compounds on the left side denote host crystals,  
9 and ions on the right side are emission centers contained  
10 in the phosphors.

1 27. The light source of Claim 25,  
2 wherein the phosphor containing the bivalent manganese  
3 as an emission center and having a peak emission at a wavelength  
4 range of 505nm to 530nm is composed of at least one of:

5 BaMgAl<sub>10</sub>O<sub>17</sub>:Eu<sup>2+</sup>, Mn<sup>2+</sup>;  
6 CeMgAl<sub>11</sub>O<sub>19</sub>:Mn<sup>2+</sup>;  
7 Ce (Mg, Zn) Al<sub>11</sub>O<sub>19</sub>:Mn<sup>2+</sup>;  
8 Zn<sub>2</sub>SiO<sub>4</sub>:Mn<sup>2+</sup>; and  
9 CeMgAl<sub>11</sub>O<sub>19</sub>:Tb<sup>3+</sup>, Mn<sup>2+</sup>

10 wherein compounds on the left side denote host crystals,  
11 and ions on the right side are emission centers contained

12 in the phosphors.

1 28. The light source of Claim 25,  
2 wherein the phosphor containing the trivalent terbium  
3 as an emission center and having an emission peak at a wavelength  
4 range of 540nm to 570nm is composed of at least one of:

5  $\text{LaPO}_4:\text{Ce}^{3+}, \text{Tb}^{3+}$ ; and

6  $\text{CeMgAl}_{11}\text{O}_{19}:\text{Tb}^{3+}$

7 wherein compounds on the left side denote host crystals,  
8 and ions on the right side are emission centers contained in  
9 the phosphors.

1 29. The light source of Claim 25,  
2 wherein the phosphor containing the trivalent europium  
3 as an emission center and having an emission peak at a wavelength  
4 range of 600nm to 620nm is composed of at least one of:

5  $\text{Y}_2\text{O}_3:\text{Eu}^{3+}$ ; and

6  $\text{Gd}_2\text{O}_3:\text{Eu}^{3+}$

7 wherein compounds on the left side denote host crystals,  
8 and ions on the right side are emission centers contained  
9 in the phosphors.

1 30. The light source of Claim 24,  
2 wherein the phosphor layer has, as major components:  
3 a phosphor containing both bivalent europium and bivalent

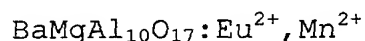
4 manganese as emission centers and having emission peaks both  
5 at a wavelength range of 440nm to 470nm and at 505nm to 530nm;

6 a phosphor containing trivalent terbium as an emission  
7 center and having an emission peak at a wavelength range of 540nm  
8 to 570nm; and

9 a phosphor containing trivalent europium as an emission  
10 center and having an emission peak at a wavelength range of 600nm  
11 to 620nm.

1 31. The light source of Claim 30,

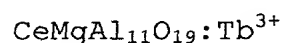
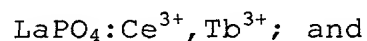
2 wherein the phosphor containing the bivalent europium and  
3 bivalent manganese as emission centers and having emission peaks  
4 both at a wavelength range of 440nm to 470nm and at 505nm to  
5 530nm is



7 wherein a compound on the left side denotes a host crystal,  
8 and ions on the right side are emission centers contained in  
9 the phosphor.

1 32. The light source of Claim 30,

2 wherein the phosphor containing the trivalent terbium  
3 as an emission center and having an emission peak at a wavelength  
4 range of 540nm to 570nm is composed of at least one of:



7 wherein compounds on the left side denote host crystals,  
8 and ions on the right side are emission centers contained in  
9 the phosphors.

1 33. The light source of Claim 30,  
2 wherein the phosphor containing the trivalent europium  
3 as an emission center and having an emission peak at a wavelength  
4 range of 600nm to 620nm is composed of at least one of:

5  $\text{Y}_2\text{O}_3:\text{Eu}^{3+}$ ; and

6  $\text{Gd}_2\text{O}_3:\text{Eu}^{3+}$

7 wherein compounds on the left side denote host crystals,  
8 and ions on the right side are emission centers contained  
9 in the phosphors.

1 34. The light source of Claim 24,  
2 wherein the phosphor containing the bivalent europium as  
3 an emission center and having a peak emission at a wavelength  
4 range of 440nm to 470nm is composed of at least one of:

5  $\text{BaMgAl}_{10}\text{O}_{17}:\text{Eu}^{2+}$ ;

6  $\text{BaMgAl}_{10}\text{O}_{17}:\text{Eu}^{2+}, \text{Mn}^{2+}$  ; and

7  $(\text{Ba}, \text{Ca}, \text{Sr}, \text{Mg})_{10}(\text{PO}_4)_6\text{Cl}_2:\text{Eu}^{2+}$

8 wherein compounds on the left side denote host crystals,  
9 and ions on the right side are emission centers contained in  
10 the phosphors.

1           35. The light source of Claim 34,  
2           wherein the phosphor containing the bivalent europium as  
3           an emission center and having a peak emission at a wavelength  
4           range of 440nm to 470nm is composed of at least one of:

5           BaMgAl<sub>10</sub>O<sub>17</sub>:Eu<sup>2+</sup>;

6           BaMgAl<sub>10</sub>O<sub>17</sub>:Eu<sup>2+</sup>, Mn<sup>2+</sup> ; and

7           (Ba, Ca, Sr, Mg)<sub>10</sub>(PO<sub>4</sub>)<sub>6</sub>Cl<sub>2</sub>:Eu<sup>2+</sup>

8           wherein compounds on the left side denote host crystals,  
9           and ions on the right side are emission centers contained in  
10          the phosphors.

1           36. The light source of Claim 34,

2           wherein the phosphor containing the trivalent terbium  
3           and the bivalent manganese as emission centers and having peak  
4           emissions both at a wavelength range of 505nm to 530nm and at  
5           540nm to 570nm is

6           CeMgAl<sub>11</sub>O<sub>19</sub>:Tb<sup>3+</sup>, Mn<sup>2+</sup>

7           wherein a compound on the left side denotes a host crystal,  
8           and ions on the right side are emission centers contained  
9           in the phosphor.

1           37. The light source of Claim 34,

2           wherein the phosphor containing the trivalent europium  
3           as an emission center and having an emission peak at a wavelength  
4           range of 600nm to 620nm is composed of at least one of:

Y<sub>2</sub>O<sub>3</sub>:Eu<sup>3+</sup>; and

Gd<sub>2</sub>O<sub>3</sub>:Eu<sup>3+</sup>

wherein compounds on the left side denote host crystals,  
and ions on the right side are emission centers contained  
in the phosphors.

38. A light source, being characterized by:

emitting light whose whiteness is no smaller than 65  
obtained when the light is reflected from a blank surface of  
a newspaper, the whiteness being calculated using chroma *C* of  
the light and an equation (7),

$$W = -3.3C + 100 \dots (7)$$

wherein the chroma *C* is calculated using a method defined  
by the CIE 1997 Interim Color Appearance Model (Simple Version);

emitting light whose chromaticity is, on the CIE 1931  
chromaticity diagram, in a range expressed by two equations (8)  
and (9); and

emitting light whose visual clarity index is no smaller  
than 110:

$$y \geq -2.63x^2 + 2.63x - 0.263 \dots (8)$$

$$y \geq -3.09x + 1.22 \dots (9).$$

39. The light source of Claim 38,

wherein the light source is a fluorescent lamp  
containing a phosphor layer, the light source emitting light



4 whose peak emissions are in four wavelength ranges of 440nm to  
5 470nm, 505nm to 530nm, 540nm to 570nm, and 600nm to 620nm; and

6 wherein a ratio of a radiant energy  $Q_v$  to a radiant  
7 energy  $Q_g$  satisfy an inequality (4) for a correlated color  
8 temperature  $T[K]$

$$9 \quad Q_g/Q_v \geq -0.11 \times 10^4/T + 0.30 \quad \dots (4)$$

10 wherein the radiant energy  $Q_v$  is in a wavelength of  
11 380nm to 780nm and radiant energy  $Q_g$  in a wavelength of 505nm  
12 to 530nm.

1 40. The light source of Claim 39,

2 wherein the phosphor layer contains, as major components:

3 a phosphor containing bivalent europium as an  
4 emission center and having a peak emission at a wavelength range  
5 of 440nm to 470nm;

6 a phosphor containing bivalent manganese as an emission  
7 center and having a peak emission at a wavelength range of 505nm  
8 to 530nm;

9 a phosphor containing trivalent terbium as an emission  
10 center and having a peak emission at a wavelength range of 540nm  
11 to 570nm; and

12 a phosphor containing trivalent europium as an emission  
13 center and having a peak emission at a wavelength range of 600nm  
14 to 620nm.

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1           41.    The light source of Claim 40,  
2            wherein the phosphor containing the bivalent europium as  
3    an emission center and having a peak emission at a wavelength  
4    range of 440nm to 470nm is composed of at least one of:

- 5           BaMgAl<sub>10</sub>O<sub>17</sub>:Eu<sup>2+</sup>;  
6           BaMgAl<sub>10</sub>O<sub>17</sub>:Eu<sup>2+</sup>, Mn<sup>2+</sup> ; and  
7           (Ba, Ca, Sr, Mg)<sub>10</sub>(PO<sub>4</sub>)<sub>6</sub>Cl<sub>2</sub>:Eu<sup>2+</sup>

8           wherein compounds on the left side denote host crystals,  
9    and ions on the right side are emission centers contained  
10   in the phosphors.

1           42.    The light source of Claim 40,  
2            wherein the phosphor containing the bivalent manganese  
3    as an emission center and having a peak emission at a wavelength  
4    range of 505nm to 530nm is composed of at least one of:

- 5           BaMgAl<sub>10</sub>O<sub>17</sub>:Eu<sup>2+</sup>, Mn<sup>2+</sup>;  
6           CeMgAl<sub>11</sub>O<sub>19</sub>:Mn<sup>2+</sup>;  
7           Ce (Mg, Zn) Al<sub>11</sub>O<sub>19</sub>:Mn<sup>2+</sup>;  
8           Zn<sub>2</sub>SiO<sub>4</sub>:Mn<sup>2+</sup>; and  
9           CeMgAl<sub>11</sub>O<sub>19</sub>:Tb<sup>3+</sup>, Mn<sup>2+</sup>

10          wherein compounds on the left side denote host crystals,  
11   and ions on the right side are emission centers contained in  
12   the phosphors.

1           43.    The light source of Claim 40,

2 wherein the phosphor containing the trivalent terbium  
3 as an emission center and having an emission peak at a wavelength  
4 range of 540nm to 570nm is composed of at least one of:

5  $\text{LaPO}_4:\text{Ce}^{3+}, \text{Tb}^{3+}$ ; and

6  $\text{CeMgAl}_{11}\text{O}_{19}:\text{Tb}^{3+}$

7 wherein compounds on the left side denote host crystals,  
8 and ions on the right side are emission centers contained in  
9 the phosphors.

1 44. The light source of Claim 40,

2 wherein the phosphor containing the trivalent europium  
3 as an emission center and having an emission peak at a wavelength  
4 range of 600nm to 620nm is composed of at least one of:

5  $\text{Y}_2\text{O}_3:\text{Eu}^{3+}$ ; and

6  $\text{Gd}_2\text{O}_3:\text{Eu}^{3+}$

7 wherein compounds on the left side denote host crystals,  
8 and ions on the right side are emission centers contained  
9 in the phosphors.

1 45. The light source of Claim 39,

2 wherein the phosphor layer has, as major components:

3 a phosphor containing both bivalent europium and bivalent  
4 manganese as emission centers and having emission peaks both  
5 at a wavelength range of 440nm to 470nm and at 505nm to 530nm;

6 a phosphor containing trivalent terbium as an emission

7 center and having an emission peak at a wavelength range  
8 to 570nm; and  
9 a phosphor containing trivalent europium as an emis  
10 center and having an emission peak at a wavelength range of 600  
11 to 620nm.

1 46. The light source of Claim 45,  
2 wherein the phosphor containing the bivalent europium and  
3 bivalent manganese as emission centers and having emission peaks  
4 both at a wavelength range of 440nm to 470nm and at 505nm to  
5 530nm is

6  $\text{BaMgAl}_{10}\text{O}_{17}:\text{Eu}^{2+}, \text{Mn}^{2+}$

7 wherein a compound on the left side denotes a host crystal,  
8 and ions on the right side are emission centers contained in  
9 the phosphor.

1 47. The light source of Claim 45,  
2 wherein the phosphor containing the trivalent terbium  
3 as an emission center and having an emission peak at a wavelength  
4 range of 540nm to 570nm is composed of at least one of:

5  $\text{LaPO}_4:\text{Ce}^{3+}, \text{Tb}^{3+}$ ; and

6  $\text{CeMgAl}_{11}\text{O}_{19}:\text{Tb}^{3+}$

7 wherein compounds on the left side denote host crystals,  
8 and ions on the right side are emission centers contained in  
9 the phosphors.

1           48. The light source of Claim 45,  
2           wherein the phosphor containing the trivalent europium  
3 as an emission center and having an emission peak at a wavelength  
4 range of 600nm to 620nm is composed of at least one of:

5            $\text{Y}_2\text{O}_3:\text{Eu}^{3+}$ ; and

6            $\text{Gd}_2\text{O}_3:\text{Eu}^{3+}$

7           wherein compounds on the left side denote host crystals,  
8 and ions on the right side are emission centers contained  
9 in the phosphors.

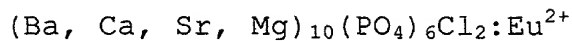
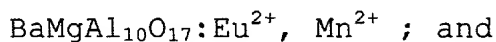
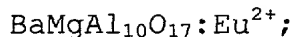
1           49. The light source of Claim 39,  
2           wherein the phosphor layer contains, as major  
3 components:  
4           a phosphor containing bivalent europium as an emission  
5 center and having an emission peak at 440nm to 470nm;

6           a phosphor containing both trivalent terbium and bivalent  
7 manganese as emission centers and having emission peaks both  
8 at a wavelength range of 505nm to 530nm and at 540nm to 570nm;  
9 and

10          a phosphor containing trivalent europium as an emission  
11 center and having an emission peak at 600nm.

1           50. The light source of Claim 49,  
2           wherein the phosphor containing the bivalent europium as  
3 an emission center and having a peak emission at a wavelength

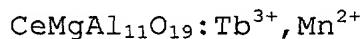
range of 440nm to 470nm is composed of at least one of:



wherein compounds on the left side denote host crystals,  
and ions on the right side are emission centers contained in  
the phosphors.

51. The light source of Claim 49,

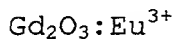
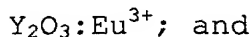
wherein the phosphor containing the trivalent terbium  
and the bivalent manganese as emission centers and having peak  
emissions both at a wavelength range of 505nm to 530nm and at  
540nm to 570nm is



wherein a compound on the left side denotes a host crystal,  
and ions on the right side are emission centers contained in  
the phosphor.

52. The light source of Claim 49,

wherein the phosphor containing the trivalent europium  
as an emission center and having an emission peak at a wavelength  
range of 600nm to 620nm is composed of at least one of:



wherein compounds on the left side denote host crystals,

8 and ions on the right side are emission centers contained  
9 in the phosphors.

1 53. A light source, characterized by:  
2 emitting light whose whiteness  $W$  is no smaller than 65 when the  
3 light is reflected from a blank surface of a newspaper, the  
4 whiteness  $W$  being calculated using chroma  $C$  of the light and  
5 an equation (11),

6 
$$W = -3.3C + 100 \dots (11)$$

7 wherein the chroma  $C$  is calculated using a method defined  
8 by the CIE 1997 Interim Color Appearance Model (Simple Version);

9 emitting light whose chromaticity is, on the CIE 1931  
10 chromaticity diagram, in a range expressed by two equations (12)  
11 and (13); and

12 emitting light whose visual clarity index is no smaller  
13 than 115:

14 
$$y \geq -2.63x^2 + 2.63x - 0.263 \dots (12)$$

15 
$$y \geq -3.09x + 1.22 \dots (13).$$

1 54. The light source of Claim 53,

2 wherein the light source is a fluorescent lamp  
3 containing a phosphor layer, the light source emitting light  
4 whose peak emissions are in four wavelength ranges of 440nm to  
5 470nm, 505nm to 530nm, 540nm to 570nm, and 600nm to 620nm; and  
6 wherein a ratio of a radiant energy  $Q_v$  to a radiant

energy  $Q_g$  satisfy an inequality (14) for a correlated color temperature  $T[K]$

$$Q_g/Q_v \geq -0.11 \times 10^4 / T + 0.30 \quad \dots (14)$$

wherein the radiant energy  $Q_v$  is in a wavelength of 380nm to 780nm and radiant energy  $Q_g$  in a wavelength of 505nm to 530nm.

55. The light source of Claim 54,

wherein the phosphor layer contains, as major components:

a phosphor containing bivalent Europium as an emission center and having a peak emission at a wavelength range of 440nm to 470nm;

a phosphor containing bivalent manganese as an emission center and having a peak emission at a wavelength range of 505nm to 530nm;

a phosphor containing trivalent terbium as an emission center and having a peak emission at a wavelength range of 540nm to 570nm; and

a phosphor containing trivalent europium as an emission center and having a peak emission at a wavelength range of 600nm to 620nm.

56. The light source of Claim 55,

wherein the phosphor containing the bivalent europium as an emission center and having a peak emission at a wavelength



4 range of 440nm to 470nm is composed of at least one of:

5 BaMgAl<sub>10</sub>O<sub>17</sub>:Eu<sup>2+</sup>;

6 BaMgAl<sub>10</sub>O<sub>17</sub>:Eu<sup>2+</sup>, Mn<sup>2+</sup> ; and

7 (Ba, Ca, Sr, Mg)<sub>10</sub>(PO<sub>4</sub>)<sub>6</sub>Cl<sub>2</sub>:Eu<sup>2+</sup>

8 wherein compounds on the left side denote host crystals,  
9 and ions on the right side are emission centers contained  
10 in the phosphors.

1 57. The light source of Claim 55,

2 wherein the phosphor containing the bivalent manganese  
3 as an emission center and having a peak emission at a wavelength  
4 range of 505nm to 530nm is composed of at least one of:

5 BaMgAl<sub>10</sub>O<sub>17</sub>:Eu<sup>2+</sup>, Mn<sup>2+</sup>;

6 CeMgAl<sub>11</sub>O<sub>19</sub>:Mn<sup>2+</sup>;

7 Ce (Mg, Zn) Al<sub>11</sub>O<sub>19</sub>:Mn<sup>2+</sup>;

8 Zn<sub>2</sub>SiO<sub>4</sub>:Mn<sup>2+</sup>; and

9 CeMgAl<sub>11</sub>O<sub>19</sub>:Tb<sup>3+</sup>, Mn<sup>2+</sup>

10 wherein compounds on the left side denote host crystals,  
11 and ions on the right side are emission centers contained in  
12 the phosphors.

1 58. The light source of Claim 55,

2 wherein the phosphor containing the trivalent terbium  
3 as an emission center and having an emission peak at a wavelength  
4 range of 540nm to 570nm is composed of at least one of:

5            $\text{LaPO}_4:\text{Ce}^{3+}, \text{Tb}^{3+}$ ; and

6            $\text{CeMgAl}_{11}\text{O}_{19}:\text{Tb}^{3+}$

7           wherein compounds on the left side denote host crystals,  
8   and ions on the right side are emission centers contained  
9   in the phosphors.

1           59. The light source of Claim 55,

2           wherein the phosphor containing the trivalent europium  
3   as an emission center and having an emission peak at a wavelength  
4   range of 600nm to 620nm is composed of at least one of:

5            $\text{Y}_2\text{O}_3:\text{Eu}^{3+}$ ; and

6            $\text{Gd}_2\text{O}_3:\text{Eu}^{3+}$

7           wherein compounds on the left side denote host crystals,  
8   and ions on the right side are emission centers contained  
9   in the phosphors.

1           60. The light source of Claim 54,

2           wherein the phosphor layer has, as major components:

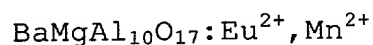
3           a phosphor containing both bivalent europium and bivalent  
4   manganese as emission centers and having emission peaks both  
5   at a wavelength range of 440nm to 470nm and at 505nm to 530nm;

6           a phosphor containing trivalent terbium as an emission  
7   center and having an emission peak at a wavelength range of 540nm  
8   to 570nm; and

9           a phosphor containing trivalent europium as an emission

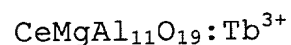
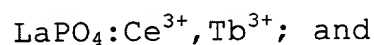
10 center and having an emission peak at a wavelength range of  
11 600nm to 620nm.

1 61. The light source of Claim 60,  
2 wherein the phosphor containing the bivalent europium and  
3 bivalent manganese as emission centers and having emission peaks  
4 both at a wavelength range of 440nm to 470nm and at 505nm to  
5 530nm is



7 wherein a compound on the left side denotes a host crystal,  
8 and ions on the right side are emission centers contained in  
9 the phosphor.

1 62. The light source of Claim 60,  
2 wherein the phosphor containing the trivalent terbium  
3 as an emission center and having an emission peak at a wavelength  
4 range of 540nm to 570nm is composed of at least one of:



7 wherein compounds on the left side denote host crystals,  
8 and ions on the right side are emission centers contained  
9 in the phosphors.

1 63. The light source of Claim 60,  
2 wherein the phosphor containing the trivalent europium

3 as an emission center and having an emission peak at a wavelength  
4 range of 600nm to 620nm is composed of at least one of:

5  $\text{Y}_2\text{O}_3:\text{Eu}^{3+}$ ; and

6  $\text{Gd}_2\text{O}_3:\text{Eu}^{3+}$

7 wherein compounds on the left side denote host crystals,  
8 and ions on the right side are emission centers contained  
9 in the phosphors.

1 64. The light source of Claim 54,  
2 wherein the phosphor layer contains, as major  
3 components:

4 a phosphor containing bivalent europium as an emission  
5 center and having an emission peak at 440nm to 470nm;

6 a phosphor containing both trivalent terbium and bivalent  
7 manganese as emission centers and having emission peaks both  
8 at a wavelength range of 505nm to 530nm and at 540nm to 570nm;  
9 and

10 a phosphor containing trivalent europium as an emission  
11 center and having an emission peak at 600nm.

1 65. The light source of Claim 64,  
2 wherein the phosphor containing the bivalent europium as  
3 an emission center and having a peak emission at a wavelength  
4 range of 440nm to 470nm is composed of at least one of:

5  $\text{BaMgAl}_{10}\text{O}_{17}:\text{Eu}^{2+}$ ;

6 BaMgAl<sub>10</sub>O<sub>17</sub>:Eu<sup>2+</sup>, Mn<sup>2+</sup> ; and

7 (Ba, Ca, Sr, Mg)<sub>10</sub>(PO<sub>4</sub>)<sub>6</sub>Cl<sub>2</sub>:Eu<sup>2+</sup>

8 wherein compounds on the left side denote host crystals,

9 and ions on the right side are emission centers contained in

10 the phosphors.

1 66. The light source of Claim 64,

2 wherein the phosphor containing the trivalent terbium  
3 and the bivalent manganese as emission centers and having peak  
4 emissions both at a wavelength range of 505nm to 530nm and at  
5 540nm to 570nm is

6 CeMgAl<sub>11</sub>O<sub>19</sub>:Tb<sup>3+</sup>, Mn<sup>2+</sup>

7 wherein a compound on the left side denotes a host crystal,  
8 and ions on the right side are emission centers contained  
9 in the phosphor.

1 67. The light source of Claim 64,

2 wherein the phosphor containing the trivalent europium  
3 as an emission center and having an emission peak at a wavelength  
4 range of 600nm to 620nm is composed of at least one of:

5 Y<sub>2</sub>O<sub>3</sub>:Eu<sup>3+</sup>; and

6 Gd<sub>2</sub>O<sub>3</sub>:Eu<sup>3+</sup>

7 wherein compounds on the left side denote host crystals,  
8 and ions on the right side are emission centers contained  
9 in the phosphors.

1           68. A luminaire, being characterized by:

2           emitting light whose whiteness is no smaller  
3   than 85 and whose visual clarity index is no smaller than 110,  
4   the whiteness  $W$  being calculated using chroma  $C$  of the light  
5   and an equation (15),

6                     
$$W = -5.3C + 100 \cdot \cdot \cdot (15)$$

7           wherein the chroma  $C$  is calculated using a method  
8           defined by the CIE 1997 Interim Color Appearance  
9   Model(Simple Version)

1           69. The luminaire of Claim 68,

2           wherein the light source is a fluorescent lamp  
3   containing a phosphor layer, the light source emitting light  
4   whose peak emissions are in four wavelength ranges of 440nm to  
5   470nm, 505nm to 530nm, 540nm to 570nm, and 600nm to 620nm; and

6           wherein a ratio of a radiant energy  $Q_v$  to a radiant  
7   energy  $Q_g$  satisfies an inequality (16) for a correlated color  
8   temperature  $T[K]$

9                     
$$Q_g/Q_v \geq -0.11 \times 10^4 / T + 0.30 \cdot \cdot \cdot (16)$$

10           wherein the radiant energy  $Q_v$  is in a wavelength of  
11   380nm to 780nm and radiant energy  $Q_g$  in a wavelength  
12   of 505nm to 530nm.

1           70. The luminaire of Claim 68,

2           wherein the light from the light source is adjusted

3 to a specified spectrum after passing through the translucent  
4 cover.

1 71. The luminaire of Claim 68,  
2 wherein the light from the light source is adjusted to  
3 a specified spectrum after reflected from the reflector.

1 72. A luminaire, being characterized by:  
2 emitting light whose whiteness  $W$  is no smaller than 85,  
3 and whose visual clarity index is no smaller than 115, the  
4 whiteness  $W$  being calculated using chroma  $C$  of the light and  
5 an equation(17)

6 
$$W = -5.3C + 100 \cdot \cdot \cdot (17)$$

7 wherein the chroma  $C$  is calculated using a method defined  
8 by the CIE 1997 Interim Color Appearance Model (Simple Version).

1 73. The luminaire of Claim 72,  
2 wherein the light source is a fluorescent lamp  
3 containing a phosphor layer, the light source emitting light  
4 whose peak emissions are in four wavelength ranges of 440nm to  
5 470nm, 505nm to 530nm, 540nm to 570nm, and 600nm to 620nm; and  
6 wherein a ratio of a radiant energy  $Q_v$  to a radiant  
7 energy  $Q_g$  satisfies an inequality (18) for a correlated color  
8 temperature  $T[K]$

$$Qg/Qv \geq -0.11 \times 10^4 / T + 0.30 \quad \cdot \cdot \cdot (18)$$

wherein the radiant energy  $Qv$  is in a wavelength of 380nm to 780nm and radiant energy  $Qg$  in a wavelength of 505nm to 530nm.

74. The luminaire of Claim 72,  
wherein the light from the light source is adjusted to a specified spectrum after passing through the translucent cover.

75. The luminaire of Claim 72,  
wherein the light from the light source is adjusted to a specified spectrum after reflected from the reflector.

76. A luminaire, being characterized by:  
emitting light whose whiteness is no smaller than 65 obtained when the light is reflected from a blank surface of a newspaper, the whiteness being calculated using chroma  $C$  of the light and an equation (19),

$$W = -3.3C + 100 \quad \cdot \cdot \cdot (19)$$

wherein the chroma  $C$  is calculated using a method defined by the CIE 1997 Interim Color Appearance Model (Simple Version);  
emitting light whose chromaticity is, on the CIE 1931 chromaticity diagram, in a range expressed by two equations (20) and (21); and



12 emitting light whose visual clarity index is no smaller  
13 than 110:

14 
$$y \geq -2.63x^2 + 2.63x - 0.263 \quad \dots (20)$$

15 
$$y \geq 3.09x + 1.22 \quad \dots (21).$$

1 77. The luminaire of Claim 76,

2 wherein the light source is a fluorescent lamp  
3 containing a phosphor layer, the light source emitting light  
4 whose peak emissions are in four wavelength ranges of 440nm to  
5 470nm, 505nm to 530nm, 540nm to 570nm, and 600nm to 620nm; and

6 wherein a ratio of a radiant energy  $Q_v$  to a radiant  
7 energy  $Q_g$  satisfy an inequality (22) for a correlated color  
8 temperature  $T[K]$

9 
$$Q_g/Q_v \geq -0.11 \times 10^4/T + 0.30 \quad \dots (22)$$

10 wherein the radiant energy  $Q_v$  is in a wavelength of  
11 380nm to 780nm and radiant energy  $Q_g$  in a wavelength of 505nm  
12 to 530nm.

1 78. The luminaire of Claim 76,

2 wherein the light from the light source is adjusted  
3 to a specified spectrum after passing through the translucent  
4 cover.

1 79. The luminaire of Claim 76,

2 wherein the light from the light source is adjusted to

a specified spectrum after reflected from the reflector.

80. A luminaire, being characterized by:

emitting light whose whiteness  $W$  is no smaller than 65 when the light is reflected from a blank surface of a newspaper, the whiteness  $W$  being calculated using chroma  $C$  of the light and an equation (23),

$$W = -3.3C + 100 \dots (23)$$

wherein the chroma  $C$  is calculated using a method defined by the CIE 1997 Interim Color Appearance Model (Simple Version); emitting light whose chromaticity is, on the CIE 1931 chromaticity diagram, in a range expressed by two equations (24) and (25); and

emitting light whose visual clarity index is no smaller than 115:

$$y \geq -2.63x^2 + 2.63x - 0.263 \dots (24)$$

$$y \geq -3.09x + 1.22 \dots (25).$$

81. The luminaire of Claim 80,

wherein the light source is a fluorescent lamp containing a phosphor layer, the light source emitting light whose peak emissions are in four wavelength ranges of 440nm to 470nm, 505nm to 530nm, 540nm to 570nm, and 600nm to 620nm; and

wherein a ratio of a radiant energy  $Q_v$  to a radiant energy  $Q_g$  satisfy an inequality (26) for a correlated color

8 temperature  $T[K]$

9 
$$Qg/Qv \geq -0.11 \times 10^4 / T + 0.30 \quad \dots (26)$$

10 wherein the radiant energy  $Qv$  is in a wavelength of  
11 380nm to 780nm and radiant energy  $Qg$  in a wavelength of 505nm  
12 to 530nm.

1 82. The luminaire of Claim 80,

2 wherein the light from the light source is adjusted  
3 to a specified spectrum after passing through the translucent  
4 cover.

1 83. The luminaire of Claim 80,

2 wherein the light from the light source is adjusted to  
3 a specified spectrum after reflected from the reflector.